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EXPERIMENTS UPON DROSERA ROTUNDIFOLIA AS TO ITS PROTEIN-DIGESTING POWER

By Winifred J. Robinson

A repetition, with some extensions, of a part of Darwin's exhaustive series of experiments on the digestive power of the leaves of *Drosera rotundifolia* was undertaken with the purpose of ascertaining whether the purer proteins now available would give any different results from those obtained by Darwin with tissue fragments or crude protein materials, solid and liquid. The experiments were carried on at the New York Botanical Garden under the direction of Professor William J. Gies, of the College of Physicians and Surgeons of Columbia University.

The plants used were collected in the bogs near Lakewood, N. J., in July, 1907. They were planted in sphagnum at the propagating house of the New York Botanical Garden, where they were kept continuously except when certain of their number were brought to the laboratory of the garden for a short time for observation.

The proteins used were prepared at the College of Physicians and Surgeons under the direction of Professor Gies with the exception of the nucleoprotein, which was extracted from compressed yeast by Professor Gies's method, in the laboratory of the New York Botanical Garden.

To insure accuracy in the records of the experiments a diagram of the arrangement of the leaves of the plant was made in each case, the point on a leaf where a protein particle was placed being indicated on the diagram by an ink spot. Observations of the plants brought to the laboratory were made at intervals of from ten to thirty minutes during the first half day,

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while those allowed to remain in the propagating house were examined daily.

Dry Egg-white *

Particles of dry white of egg were placed upon all the leaves of a plant on October 13, 1907. The tentacles curved slowly but at the end of 24 hours were tightly closed over albumen particles. At the end of three days the albumen had entirely disappeared and was no doubt pretty thoroughly digested.

In the use of such crude products as egg-white, as was the case in practically all of Darwin's *Drosera* experiments, the possible influence of salts and other non-protein compounds in the materials employed, is ignored. In the remaining experiments, accessory substances, such as inorganic salts and extractives, have had no influence, for they were completely eliminated from the protein samples in the course of their preparation.

Acidalbumin

Acidalbumin particles were placed upon all the leaves of a plant on October 13, 1907, but the response was slight, and the albuminate remained at the end of three days.

Alkali Albuminate

Alkali albuminate particles were placed upon the leaves of a third plant, October 13, 1907, with a result similar to that in the case of the acidalbumin.

The results of the foregoing experiments show that egg albumen causes a response of the tentacles and ultimate digestion, while the acidalbumin and alkali albuminate both cause a much less vigorous response. The plants upon which the experiments were tried were just ready to enter the resting stage so it is hardly fair to say that they would not more readily digest the acidalbumin and alkali albuminate if the plants had been in prime condition. It is possible, of course, that the prior separation of saline matters and other impurities from the albuminates, removed an effective digestive stimulus.

* This was the only crude product employed. All others were chemically pure.

Edestin

Particles of crystalline edestin were placed on each leaf of a single plant on October 13, 1907. The response of the plant was very slow, and at the end of 24 hours the edestin granules showed no apparent change. Gradually, however, they were dissolved and at the end of three days had disappeared.

Fibrin

Small shreds of fibrin* were placed upon a leaf August 26, 1907, at 2:30 P. M., the plant being kept in the laboratory under a bell-jar, with tubulure, for observation. At the end of 4 hours the tentacles had curved inward and, after 19 hours had elapsed, the particles had been carried from the margin to the center of the disc. At the end of 67 hours a part of the fibrin remained, with the tentacles still slightly closed over it.

On August 26, 1907, small shreds of fibrin were placed on one leaf of each of three plants, which were left at the propagating house; 24 hours later the tentacles were tightly closed over the fibrin in each case. They remained closed through the sccond day, when they expanded fully. The fibrin had been partially dissolved. Some of the tentacles on two of these leaves were closed over insects. Fibrin was then placed upon the other tentacles, and these continued to be closed after those which digested the fibrin had expanded again.

In an experiment begun October 13, 1907, shreds of fibrin were placed on all the leaves of one plant; 24 hours later the response was slight but at the end of 3 days the fibrin had dissolved.

The results of these experiments show that fibrin, as pure as it can be prepared by the best methods, is dissolved and digested when placed upon leaves of *Drosera rotundifolia.*

Tendomucoid

Small particles of tendomucoid were placed upon two leaves of the same plant, September 18, 1907, and soon dissolved, the glistening drop of solution remaining some time upon the leaf.

* Given special care in purification. Ash content was only 0.4 per cent.

On September 23 the experiment was repeated with similar results.

On October 13 the experiment was again repeated. This time the plant was kept in the laboratory under a bell-jar, with tubulure, and the drop of dissolved mucoid disappeared, hence it was inferred that digestion had occurred at the end of three days.

Yeast Nucleoprotein

September 10 particles of yeast nucleoprotein were placed upon a leaf of a plant in the laboratory. The tentacles slowly closed over it and remained closed three days.

On September 11 the experiment was repeated with the difference that the nucleoprotein was moistened with distilled water before it was used. The result was like that of the preceding experiment. The nucleoprotein became dark-colored in each experiment before it disappeared.

From the response of the tentacles and the disappearance of the nucleoprotein it was inferred that digestion had slowly taken place.

Tendocollagen

Fragments of collagen fibers from tendon were placed upon three leaves of one plant. The tentacles bent but did not close tightly. No change in size or appearance of the collagen particles was observed during four days.

The experiment was repeated September 23, upon a young leaf, with a result similar to the above.

September 27 and October 13 the experiment was repeated upon mature leaves, the result in each case being a bending of the tentacles within half an hour with no further change, hence the response may be attributed to contact stimulus rather than to digestion.

Ligament Elastin

Particles of ligament elastin were placed on a leaf of a plant in the laboratory August 26, at 2:30 P. M. Observations were made at intervals of half an hour during the first four hours, but no response was noted. Daily observations showed no response

at the end of a week. On the same day elastin was placed on several leaves of each of two plants in the propagating house. No change was noted in three days.

On September 3 nine leaves of a single plant in the propagating house were washed with distilled water, after which particles of elastin which had been moistened with distilled water were placed upon them. No movement of the tentacles was observed during six days. On the same day particles of elastin which had been moistened with dilute Liebig's meat extract were placed upon two leaves of a plant in the propagating house. Observations were made on three successive days, but no change was seen. (Note the negative results with creatin recorded in the next section of this paper.)

On September 4 particles of elastin moistened with distilled water were placed upon eleven leaves of a plant in the laboratory; three hours later a slight bending of the tentacles was noted. The following morning all the tentacles had recovered, without effect on the elastin. On the same day particles of dry elastin were placed upon nine leaves of a single plant in the laboratory. After three hours a slight bending of the tentacles nearest the elastin was noted, but, after an interval of twenty hours, all the tentacles had recovered. There was no effect on the elastin.

On October 13 the experiment was repeated in the laboratory with similar results.

Elastin, then, is not digested by the leaves of these plants.

Creatin

Creatin particles were placed upon three leaves of one plant, September 18, in the propagating house. They dissolved but caused no bending of the tentacles. The drops of fluid were present on the leaves for five days, but had disappeared entirely by the ninth day.

On September 23, the experiment was repeated upon one leaf of each of four plants. The creatin dissolved within an hour and a beadlike drop remained for three days on each tentacle upon which the creatin had fallen. No bending of tentacles nor other response occurred.

In Darwin's experiments with meat, creatin (and presumably the other nitrogenous extractives of meat) had seemingly no influence.

General Conclusions

The results of these experiments indicate the ready digestibility of dry egg-white, fibrin, tendomucoid, and nucleoprotein. Acid-albumin, alkali albuminate, and edestin were digested, but somewhat less readily than the products first named. Collagen and elastin appeared to be entirely indigestible. Even when moistened with meat extract the elastin particles failed to undergo digestive alteration. Creatin did not cause bending of the tentacles.

These observations cannot be directly compared with Darwin's because Darwin dealt with mixtures or crude products.

The proteolytic enzymes of *Drosera* are, like those of other organisms, able to digest some proteins and unable to digest others.

New York Botanical Garden

SPECIES OF GYMNOSPORANGIUM IN SOUTHERN ALABAMA

By R. E. Stone

While connected with the Alabama Agricultural Experiment Station I became interested in the distribution of certain fungi, especially species of *Gymnosporangium*. The presence of several species of cedar as well as many species of the Pomaceae would indicate that many species of the genus *Gymnosporangium* might be found.

Up to the present time the species reported for Alabama are: *Gymnosporangium macropus* Link, *G. globosum* Farl., *G. Clavipes* C. & P., *G. flaviforme* Atk., and *G. Nidus-avis* Thax. All of these are reported as occurring on *Sabina virginiana* (L.) Antoine.

The presence of *Chamaecyparis thyoides* (L.) B.S.P. and also of *Amelanchier canadensis* (L.) Medic. and *Aronia* (L.) Ell. lead me to believe that *Gymnosporangium biseptatum* Ellis or *Gymno-*